Space Launch Report: H-IIA/B Data Sheet

H-IIA/B

Vehicle Configurations

Vehicle Components

H-2(A/B) Launch History

H-IIA and H-IIB are Japan's primary launch vehicles. H-IIA was an improved version of H-II, the country's first liquid hydrogen fueled booster. H-IIB replaced the H-IIA single-engine first stage with a wider body, dual-engine stage.

H-II

H-2 F2

Two-and-one-half stage H-II could boost 4 metric tons into geosynchronous transfer orbit (GTO). H-IIA could lift nearly 6 tonnes . H-IIB could haul 8 tonnes.

National Space Development Agency of Japan (NASDA) launched the first H-II on February 3, 1994. Six more flew during the next five years. The first five H-IIs succeeded, but the last two failed. The rocket, which consisted of 4 meter diameter first and second stages augmented by a pair of segmented solid rocket boosters (SRBs), turned out to be both costly and complex. Cost reduction was the primary reason that NASDA developed H-IIA.

H-IIA

H-2A TF2 was a 2024 model with two SRB-A and four SSB strap-on boosters.

The standard H-IIA, dubbed H2A202, used simplified, lower-cost core motors and new, single-segment, lower-cost strap-on solid rocket boosters (SRB-As) to put 4.1 tons into GTO or 10 tons into low earth orbit (LEO). H2A202 weighed 287 tons at liftoff, excluding payload, and stood 52.5 meters tall. During the first 100 seconds of flight, the rocket was powered by two SRB-A strap-ons producing 230 tons vacuum thrust each to augment the single LE-7A core stage engine's 112 tons vacuum thrust.

LE-7A, a staged combustion cycle engine that could throttle, ignited on the launch pad and burned for 400 seconds. The single-chamber engine gimbaled for pitch and yaw control. Auxiliary jets, fed by low-mixture ratio gas from the main engine preburner mixed with hydrogen gas, provided first stage roll control.

The H-IIA second stage was modified in several ways from its H-II precursor. It was powered by a simplified, multi-restartable LE-5B LOX/LH2 engine, which provided 14 tons thrust for up to 534 seconds. LE-5B gimbaled for pitch and yaw control while the second stage reaction control system (RCS) used hydrazine jets for roll control during powered flight and for roll/pitch/yaw control during unpowered flight.

H-2A F11, flown in 2006, was the first, and by 2014 only, H-2A 204 model with four SRB-A boosters.

The second stage used a simplified structure, consisting of separate propellant tanks held together by 24 carbon composite support trusses. (H-II's second stage tanks used a more difficult to manufacture common bulkhead.) The upper, 4-meter diameter second stage LH2 tank, built by Mitsubishi Heavy Industries (MHI), was essentially

the same structure supplied by MHI to Boeing for its Delta III and Delta IV-M second stage LH2 tanks. An elliptical LOX tank, roughly 3 meters in diameter, sat below the LH2 tank and was housed within the intertank structure until the first stage fell away.

The H-IIA strap-down inertial guidance system, located on the second stage, controled the entire vehicle during flight.

H-IIA growth versions soon entered service. H2A2022, with two additional smaller solid strap on boosters (SSB), could boost 4.5 tons to GTO. H2A2024 used four SSBs to put 5 tons into GTO. H2A204, with four SRB-As, could put 6 tons into GTO.

Larger versious of H-IIA were studied, but dropped. Initial concepts for an H2A212 variant consisted of a standard H-IIA with a parallel liquid rocket booster (LRB) powered by two LE-7A engines, capable of boosting 6 tons to GTO. This was replaced by plans to build an "H-IIB" with a larger, 5.2 meter diameter first stage powered by two LE-7A engines.

H-IIA was stacked vertically in the Yoshinobu Launch Complex Vehicle Assembly Building at Tanegashima, a building that was enlarged to two bays for the H-IIA program. On launch day it was rolled on a massive, rubber-wheeled mobile launch table to one of two seaside launch pads. For H-IIA, a second pad was added near the original H-II pad. Tanegashima launches could take place only during 190 days each year during January-February and June-September, and November-December due to agreements with local fisherman.

The first H-IIA lifted off in 2001. After five successful missions, the sixth H-IIA, launched in 2003, failed to reach orbit. That failure occurred when one of two SRB-A boosters failed to separate. The root cause of this failure was an insulation burn-through on the SRB-A nozzle that allowed hot gases to damage a separation detonating fuse. When the time came for the SRB-A to jettison, the fuse failed to fire and the solid booster remained attached to the first stage. The rocket continued to fly down range, with the second stage separating and starting, but the extra mass robbed the vehicle of so much velocity that it was not possible to reach orbit. A range safety destruct command was transmitted 11 minutes into the flight.

H-2A F23 was an example of the common "Standard" H-2A 202 that commonly flew after 2008.

H-IIA successfully returned to flight with a beefed up SRB-A design in 2005. In 2007, H-IIA F13 successfully launched Japan's first large lunar orbiter, SELENE (KAGUYA), "The largest lunar mission since the Apollo program". The SELENE complex weighed about 3.09 tonnes at liftoff, making it the heaviest lunar explorer since Luna 24 in 1976.

H-IIA F14, a 2024 model used to launch the KIZUNA "Internet satellite" to GTO in 2008, used improved SRB-A booster nozzles and a new LE-5B-2 (improved LE-5B) second stage engine. The changes increased SRB-A vacuum specific impulse from 280 seconds to 282.5 seconds. The LE-5B-2 engine provided 448 second specific impulse, a 1 second improvement from LE-5B. The changes allow more payload. KIZUNA weighed 4.85 tonnes at liftoff. H-2A was formerly rated for only 4.7 tonnes to GTO.

After 2008, use of SSB motors was discontinued, resulting in retirement of the 2022 and 2024 types. Seven 2024 launches and three 2022 launches took place between 2002 and 2008.

H-IIB

H-IIB was developed to launch Japan's H-II Transfer Vehicle (HTV), an unmanned spacecraft designed to haul cargo to the International Space Station. HTV, which weighed up to 16.5 tonnes, could haul up to 6 tonnes of wet and dry cargo. H-IIB consisted of a 5.2 meter diameter core stage, powered by two LE-7A engines, that was augmented by four SRB-A strap on motors. The second stage was essentially the same as the H-IIA version. A new 5.1 meter diameter payload fairing was used for the initial HTV flights.

In addition to its LEO heavy lifting capability, the more powerful H-IIB rocket could lift up to 8 tonnes to GTO. This ability made H-IIB the third most capable GTO launch vehicle in the world, after Delta IV Heavy and Ariane 5 ECA.

Japan Aerospace Exploration Agency (JAXA) launched its first H-2B launch vehicle, carrying Japan's first HTV ISS cargo spacecraft, from Tanegashima Space Center on September 10, 2009. The 56.6 meter tall, 531 tonne 2.5 stage rocket lifted off from Yoshinobu Launch Pad 2 at 17:01 UTC to start H-2B Test Flight 1. HTV-1 entered a 51.6 degree inclination low earth orbit about 15 minutes later.

All four SRB-A boosters ignited on the pad and burned for 1 minute 50 seconds. The twin LE-7A engines burned for 5 minutes 47 seconds. The 4 meter diameter second stage, powered by a single LE-5B LOX/LH2 engine, burned for about 8 minutes 13 seconds to inject HTV-1 into orbit.

Vehicle Configurations

	LEO Payload (metric tons) 250 km x 30 deg [1] 250 km x 51.6 deg [2]	GTO Payload 1800 m/s from GEO* (metric tons)	Configuration	LIftoff Height (meters)	Liftoff Mass (metric tons) not including payload
H-IIA 202	10 t [1]	3.8 t	2SRB-A + Stg1	53	290 t

			+ Stg2 + PLF		
H-IIA 2022 (retired)		4.2 t	2SRB-A + 2SSB + Stg1 + Stg2 + PLF	53 m	320 t
H-IIA 2024 (retired)		4.7 t 5.0 t**	2SRB-A + 4SSB + Stg1 + Stg2 + PLF	53 m	350 t 348 t**
H-IIA 204		5.7 t	4SRB-A + Stg1 + Stg2 + PLF	53 m	445 t
H-IIB 304	16.5 t [2]	8 t	4SRB-A + H2BStg1 + Stg2 + PLF	56.6 m	531 t

* GEO: Geosynchronous Earth Orbit
** Beginning with F14

Vehicle Components

	SRB-A (each)	SSB (each)	H-IIA 1st Stage	H-IIB 1st Stage	H-IIA/B 2nd Stage	H-IIA Payload Fairing	H-IIB 5S-H Payload Fairing
Diameter (m)	2.5 m	1 m	4.0 m	5.2 m	4.0 m	4.07 m	5.1 m
Length (m)	15.1 m	14.9 m	37.2 m	38 m	9.2 m	12.0 m	15 m
Propellant Mass (tons)	66 t 65 t**	13.1 t	101.1 t	177.8 t	16.9 t		
Total Mass (tons)	77 t 75.5 t**	15.5 t	114 t	202 t	20.0 t	1.4 t	3.2 t
Engine	SRB-A	SSB	LE-7A	2xLE-7A	LE-5B LE-5B-2**		
Engine Mfgr	Nissan						
Fuel	Solid	Solid	LH2	LH2	LH2		
Oxidizer			LOX	LOX	LOX		
Thrust (SL tons)							
Thrust (Vac tons)	230 t	75.97 t	112 t	223.9 t	14 t		
ISP (SL sec)							
ISP (Vac sec)	280 s 282.5 s**	282 s	440 s	440 s	447 s 448 s**		
Burn Time (sec)	100 s	60 s	397 s	352 s	530 s		
No. Engines	1	1	1	2	1		

** Beginning with F14

H-2(A/B) Launch History

DATE	VEHICLE	ID	PAYLOAD	MASS(t)	SITE*	ORBIT**
02/03/94	H-2	1F	OREX	3.256	TA Y1	GTO [1a]
08/28/94	H-2	2F	ETS-6/LAPS	3.80	TA Y1	GTO [1b]
03/18/95	H-2+SSB	3F	SFU/GMS-5	4.747	TA Y1	GTO [1c]
08/17/96	H-2	4F	ADEOS/JAS 2	3.70	TA Y1	LEO/S

11/27/97	H-2	6F	TRMM/ETS-7	6.52	TA Y1	LEO [1d]
02/21/98	H-2	5F	COMETS	3.90	TA Y1	[EEO] [1]
11/15/99	H-2S [LE5B]	8F	MTSAT	2.90	TA Y1	[FTO] [2]
08/29/01	H-2A-202	TF1	VEP-2/LRE	4.00?	TA Y1	GTO
02/04/02	H-2A-2024	TF2	MDS/DASH	0.572	TA Y1	GTO [3a]
09/10/02	H-2A-2024	TF3	USERS/DRTS	3.30	TA Y1	GTO [3b]
12/14/02	H-2A-202	TF4	ADEOS 2/3xusats	3.856	TA Y1	LEO/S
03/28/03	H-2A-2024	F5	IGS-Optical 1/Radar 1	2.05	TA Y1	LEO/S
11/29/03	H-2A-2024	F6	IGS-Optical/Radar	2.05	TA Y1	[FTO] [3]
02/26/05	H-2A-2022	F7	MT-Sat 1R	3.30	TA Y1	GTO
01/24/06	H-2A-2022	F8	ALOS	4.00	TA Y1	LEO/S
02/18/06	H-2A-2024	F9	MTSAT-2	4.65	TA Y1	GTO
09/11/06	H-2A-202	F10	IGS-Optical 2	0.85	TA Y1	LEO/S
12/18/06	H-2A-204	F11	ETS-8	5.80	TA Y1	GTO
02/24/07	H-2A 2024	F12	IGS-Radar 2/Optical 3V	~2.05	TA Y1	LEO/S
09/14/07	H-2A-2022	F13	SELENE Lunar Orbiter	3.09	TA Y1	HTO
02/23/08	H-2A/2024	F14	KIZUNA (WINDS)	4.85	TA Y1	GTO
01/23/09	H-2A-202	F15	GOSAT (Ibuki)	1.98	TA Y1	LEO/S
09/10/09	H-2B-304	TF1	HTV 1	16.00	TA Y2	LEO/ISS[4]
11/28/09	H-2A-202	F16	IGS Optical 3	-	TA Y1	LEO/S
05/20/10	H-2A-202	F17	Akatsuki/Ikaros	0.81	TA Y1	HCO [5]
09/11/10	H-2A-202	F18	Michibiki	4.00	TA Y1	GTO/i
01/22/11	H-2B-304	F2	HTV-2	16.00	TA Y2	LEO/ISS
09/23/11	H-2A-202	F19	IGS-Optical 4	-	TA Y1	LEO/S
12/12/11	H-2A-202	F20	IGS-Radar 3	-	TA Y1	LEO/S
05/17/12	H-2A-202	F21	GCOM W1/Kompsat 3	2.848	TA Y1	LEO/S
07/21/12	H-2B-304	F3	HTV-3(Kounotori)	15.90	TA Y2	LEO/ISS
01/27/13	H-2A-202	F22	IGS Radar 4/Optical 5	-	TA Y1	LEO/S
08/03/13	H-2B-304	F4	HTV-4	15.90	TA Y2	LEO/ISS
02/27/14	H-2A-202	F23	GPM Core Observatory	3.85	TA Y1	LEO
05/24/14	H-2A-202	F24	ALOS 2 + 4usats	2.275	TA Y1	LEO/S
10/07/14	H-2A-202	F25	Himawari 8	3.5	TA Y1	GTO
12/03/14	H-2A-202	F26	Hayabusa 2	0.71	TA Y1	HCO [6]
02/01/15	H-2A-202	F27	IGS-Radar Spare	-	TA Y1	LEO/S
03/26/15	H-2A-202	F28	IGS Optical 5		TA Y1	LEO/S
08/19/15	H-2B-304	F5	HTV-5	16.2	TA Y2	LEO/ISS
11/24/15	H-2A-204	F29	Telstar 12V	4.9	TA Y1	GTO [7]
02/17/16	H-2A-202	F30	Astro H	2.7	TA Y1	LEO
11/02/16	H-2A-202	F31	Himawari 9	3.5	TA Y1	GTO
12/09/16	H-2B-304	F6	HTV-6	~15.0	TA Y2	LEO/ISS
01/24/17	H-2A-204	F32	DSN 2		TA Y1	GTO
03/17/17	H-2A-202	F33	IGS Radar 5		TA Y1	LEO/S
06/01/17	H-2A-202	F34	Michibiki 2	4.0	TA Y1	GTO/i[8]
08/19/17	H-2A-204	F35	Michibiki 3	~4.7	TA Y1	GTO
10/09/17	H-2A-202	F36	Michibiki 4	4.0	TA Y1	GTO/i
12/23/17	H-2A-202	F37	GCOM-C/SLATS	2.4	TA Y1	LEO/S [9]

02/27/18 H-2A-202 F38 IGS Optical 6 TA Y1 LEO/S

NOTES:

[1a] Test flight sent 2.39 tonne Vehicle Evaluation Payload (VEP) dummysat to GTO and 0.865 tonne Orbital Re-entry Experiment (OREX) to LEO. OREX completed one orbit and reentered to acquire re-entry data for HOPE spaceplane project.

[1b] H-2 successfully inserted ETS 6 (Engineering Test Satellite) and its LAPS (Liquid Apogee Propolsion Stage) into GTO, but LAPS failed to raise orbit to GEO. Left in 8,565 x 38,677 km x 13.23 deg orbit. ETS 6 weighed 2 tonnes. LAPS weighed 1.8 tonnes.

[1c] GMS 5 (Geostationary Meteorological Satellite) and Star 27 AKM weighing 0.747 tonnes were placed into GTO. SFU 1 (Space Flyer Unit) weighing 4 tonnes placed in LEO x 28.4 deg. SFU 1 was retrieved by STS-72 on 01/13/96.

[1d] TRMM (Tropical Rainfall Measuring Mission) weighed 3.62 tonnes. ETS 7 docking experiment consisted of 2.5 tonne target and 0.4 tonne chaser. All placed in LEO x 35 deg.

[1] COMETS (Communication Engineering Test Satellite) left in unusable orbit. The second Stage 2 burn cut off after 44 seconds instead of planned 3m 12s due to LE-5A engine nozzle failure.

[2] 1st stg engine H2 leak, failed at T + 4 minutes.

[3a] DASH (Demonstrator of Atmospheric reentry System with Hyperbolic velocity) was intended for LEO reentry test, but failed to separate.

[3b] 2.8 tonne DRTS (Data Relay Test Satellite) to GTO. 0.5 tonne USERS (Unmanned Space Experiment Recovery System) to LEO for reentry test.

[3] One SRB-A failed to separate. RSO signal transmitted at T + 11 minutes.

[4] First H-2B with dual-engine core, carrying first HTV 1 cargo spacecraft to ISS.

[5] Akatsuki toward Venus orbit. Ikaros a solar sail demonstrator in HCO.

[6] Asteroid sample return, 6 year mission. HCO mass includes three microsats.

[7] First 3-burn second stage mission, to 2,700 x 36,585 km x 20.1 deg.
[8] To 250 x 36,140 km x 31.9 deg inclined GTO. Sat to raise self to 33,100 x 38,500 km x 44 deg quazi-geosynchronous orbit.
[9] First 3-burn Stg 2 mission. Sats to two different orbits.

ABBREVIATIONS:

[FTO]: Failed to Orbit
[EEO]: Unintended Eliptical Earth Orbit
[GTO]: Unintended Geosynchronous Transfer Orbit
[LEO]: Unintended/Improper Low Earth Orbit

"KA" = Kagoshima Space Center
"TA" = Tanegashima Space Center
"Y" = Yoshinobu Launch Complex

References

H-IIA Brief Description, NASDA, December 2001
H-IIB Product Description, NASDA, 2009

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